HDM99

Dialysis Measuring System

User Manual

The information contained in this documentation can undergo changes without special announcement. IBP Instruments GmbH takes no responsibility with this document. The contained software is being delivered on the basis of a general licence contract or in single license. Use or reproduction of the software is allowed only in agreement with the contractual arrangements. Whoever transfers this software and/or this manual on magnetic tape, diskette or any other media, except for the purpose of own use, without written authorization of the IBP Instruments GmbH, is liable to prosecution.

Copyright (C) 1996-2000, IBP Instruments GmbH.
All rights reserved

Publisher:
IBP Instruments GmbH
Sutelstr. 7A
D 30659 Hannover

IBP Instruments Inc
635 South Orange Avenue.
Sarasota, FL 34236

Manual author:
Werner Pfingstmann
3rd Edition August 2000

Attention

Read these safety instructions before using the HDM99

- **Please read the manual before using the HDM99.**
- **Keep away the device from unauthorized persons.**
- **Never use the HDM99 with connected battery charger on a dialysis machine to which a patient is connected.**
- **Operate the instrument only in a dry environment, and do not touch it with damp hands. Ensure that no fluids intrude into the interior of the device or into the sockets at the front.**
- **Apply a protection filter to the nozzle for the pressure measurement .**
- **Avoid a discharge of static electricity over the sockets. It could lead to the destruction of your measuring device. Before touching the sockets and lines that are connected with them, keep an eye on the discharging of static electricity.**
- **Voltages above 40V can be dangerous. Take extreme care while working with higher voltages.**
- **To avoid electrical shocks, and/or damage to your measuring system, do not apply excess voltages above 40 V to the instrument.**
- **Only calibrate the device if you have understood the consequences to their full extent.**
- **Do not open the device.**

DELIVERY EXTENT **6**

EC-CONFORMITY DECLARATION **7**

GUARANTEE DIRECTIVES **8**

INTRODUCTION **9**

CONNECTIONS 10
CHARGE CONNECTION 11
TURNING ON THE DEVICE 13
MAIN MENU 13
MEASUREMENT 15

TEMPERATURE MEASUREMENT **17**

CONDUCTIVITY MEASUREMENT **18**

CONDUCTIVITY AND TEMPERATURE MEASUREMENT **21**

FURTHER POSSIBLE MEASUREMENTS **25**

PH MEASUREMENT **26**

PH-CALIBRATION IN THE MEASURING MODE 30

FLOW MEASURING **31**

MANAGEMENT OF DIFFERENT SENSORS 31
COUNTER 34

POOL MENU **35**

VOLTAGE MEASUREMENT - PLOTTER **36**

VOLTAGE MEASUREMENT - OSCILLOSCOPE **38**

BATTERY VOLTAGE **40**

INSTALLATION **41**

LANGUAGE 41
SWITCH-OFF TIME 41
ADJUST-RESET 42

CALIBRATION OF THE HDM99 ..... **43**

ADJUSTMENT 43
CALIBRATION OF TEMPERATURE MEASUREMENT 45
CALIBRATION OF CONDUCTIVITY MEASUREMENT 47
CALIBRATION OF THE PRESSURE MEASUREMENT 51
CALIBRATION OF PH-MEASUREMENT 53

PH-CALIBRATION **54**

CALIBRATION OF FLOW **55**

CALIBRATION OF THE VOLTAGE MEASUREMENT **57**

MAINTENANCE AND CARE OF THE HDM99 ..... **58**

STORAGE 58
CLEANING 59
CALIBRATION INTERVALS 60

SPECIFICATIONS FOR THE HDM99 ..... **62**

RS-232-INTERFACE **64**

HDMCMO STARTS BACKGROUND MEASUREMENT **66**

12964.12/ 24.7/ 750/ 7.00/ -0.03/ 0.05/6.12/1200/1000/79131/999999 + CR LF → 73 SIGNS **66**

Delivery extent

The hardware of HDM99 consists of:

HDM99

Combined electrode conductivity / temperature
Flow-through connector for conductivity/temperature probe
Pressure measuring tube
Voltage measuring cables
Count input measuring cables
Battery charger
Standard solution conductivity 13,63 mS/cm

The documentation of HDM99 consists of this manual.

If you should miss anything, please contact your supplier.

EC-Conformity Declaration

Hereby we declare that the HDM99 corresponds to the basic requirements for protection according to the guidelines of the board for the assimilation of legal regulations about electro-magnetic compatibility (89/336/EWG) of the member states.
For the rating of the devices in view to their electro-magnetic compatibility the following norms have been used:

Emission:	EN 55022 Class B
Immission:	IEC 801-3 Criterion A
	IEC 801-2 Criterion A
	IEC 801-4 Criterion B

This declaration is responsibly given for

IBP Instruments GmbH
Sutelstr. 7A
30659 Hannover

by

Dipl. Ing. Werner Pfingstmann
Managing director

Hannover, September 30, 1996

Guarantee directives

The existing product is a technical device which contains only modern electronic components. During the manufacturing exclusively first choice parts are used. Each device undergoes extensive tests before delivery.
IBP warrants that the device is free from defects in material and workmanship for a period of 12 months beginning at the date of delivery. Excluded from the guarantee are damages by improper treatment, inappropriate usage, by connecting to excess voltages, modifications in the device or through risks which the user has to cover by a suitable insurance (fire, water, intrusion, robbery etc.)
All conceivable measures were met to assure the accuracy of this product-documentation. IBP cannot grant any guarantee for the completeness and the accuracy of the software and the documentation. IBP is not responsible for damages (including, but not limited to, damages for loss of business profits, business interruption, loss of data, and other special, incidental or consequential damages) which emerge through the usage of the product by the customer.

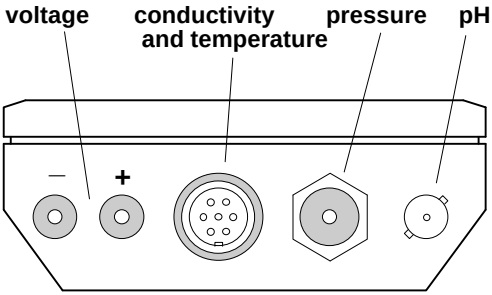
Introduction

HDM99 is an innovative computer processed measuring system with which nine parameters can be measured:

Conductivity
Temperature
Pressure
pH
Flow
Voltage
Frequency
Period time
Events

The device has been developed for the usage on dialysis machines, but is also usable in the labor in the environmental measuring technology.
The handling is uncomplicated and follows the motto: Only the manual is necessary in cases of doubt.
The entire handling is led by dialogues. The calibration of the device by the user is simple and gives no problems.
The display of measurement results is available n numerical and also in graphical form.
Via the serial interface the measurements can be called independently of the current display, and further processed or presented on a PC. For the fault location at dialysis machines IBP has developed a program that presents and processes measurements of the HDM99 and of the machine together. Provided that the dialysis machine is equipped with an interface according to RS232- or RS485-standard. Drivers for different instruments are available or in preparation. The program runs under MS-Windows and is therefore easy to operate.

Connections



Voltage

The sockets are intended only for AC and DC voltages up to 40 V. They are protected up to 80 V.

Conductivity / Temperature

The conductivity measurement is designed for quadropole technology. Please use exclusively the electrode delivered with the device by IBP.

Pressure

To avoid damages at the pressure probe or inaccuracies in measurement, ensure that no fluids intrude into the device.
We recommend the application of a protection filter.

pH

The input bushes are intended exclusively for pH-electrodes. Other signals may destroy the device.

Flow

The connection is to be found at the right side of the device. (8pol. connector)

Frequency, Periodicity and Events

The connection on the right side of the device is also used for the measuring of the flow. The incoming voltage range is +5...+24 V. The form of the signal should be of a rectangular form and has to be positive**.**

Charge connection

The charge connection is found at the right side of the device. The connection is provided with 12 V / 500 mA by the included battery charger.

For safety reasons never use the HDM99 with connected battery charger on a dialysis machine to which a patient is connected.

Combined electrode in Hansen-connector

In the flow-through mode the connector is suitable for measuring pressure, temperature and conductivity. In the dip-in mode temperature and conductivity can be measured. The preferential position of the Hansen-connector is vertical, the axial supply shows downward.

In the flow-through mode the axial supply is used as input and the radial supply as output (see illustration). The pressure probe in HDM99 is fastened to the radial connection above the input. Before any measurements you must shake the connector to assure that any air within the system escapes.

For the dip-in mode open the screw cap at the upper end of the connector and extract the combined electrode. You must not remove the tube covering the probe carrier. Dip the electrode into the media up to a level above the borings in the covering tube. By moving the electrode you assure that the contained air can escape and the temperature is well balanced.

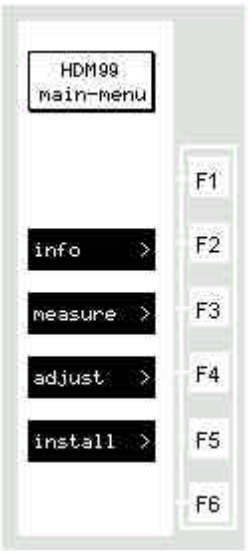
Do not touch the surface of the electrode with your fingers.

Turning on the device

The device is switched on and off with the keys ON and OFF. In addition to that, the device automatically switches off when the accumulator is exhausted, or after the elapsing of an adjustable time.

Main menu

After switching on the device you receive an information menu for approx. two seconds. After that the system goes back to the last setting. In some cases you will receive the following main menu.



Activation of the function keys leads to

display of the info-menu

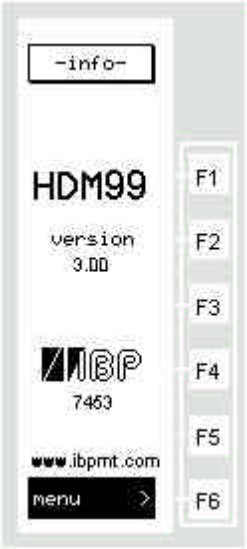
display of the measuring menu

display of the calibration menu

display of the installation menu

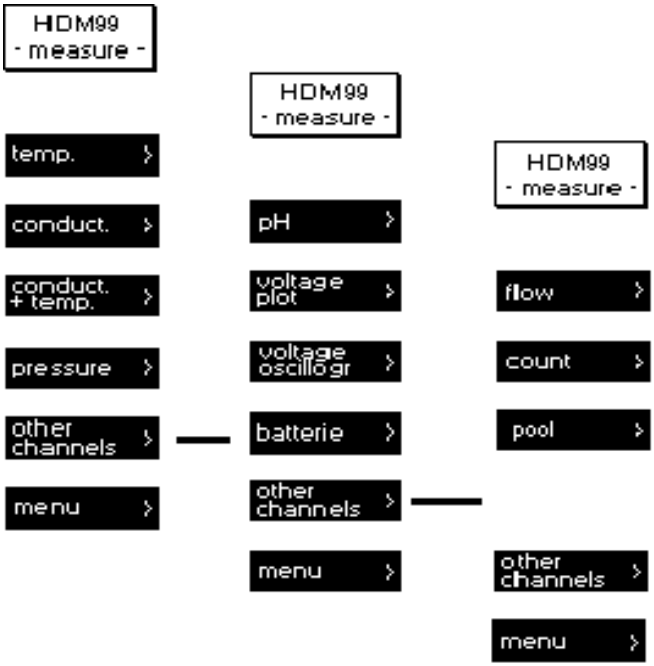
Info

From the root menu via *info* you receive the following information:
There are device specific data like product name, software version and version date as well as the serial number of your HDM99.

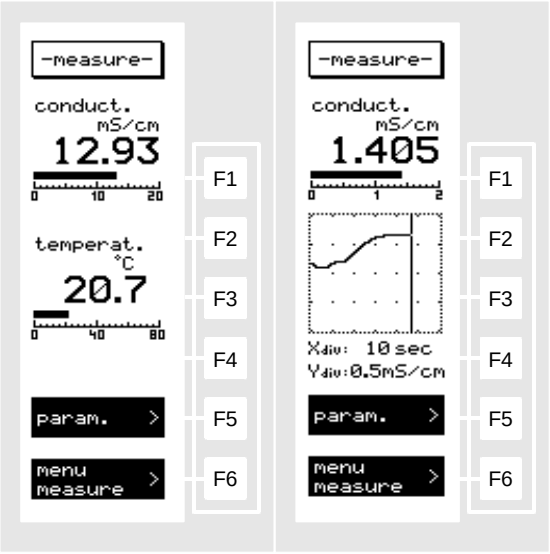


Measurement

From the main menu over *measuring* you will receive the following menu:

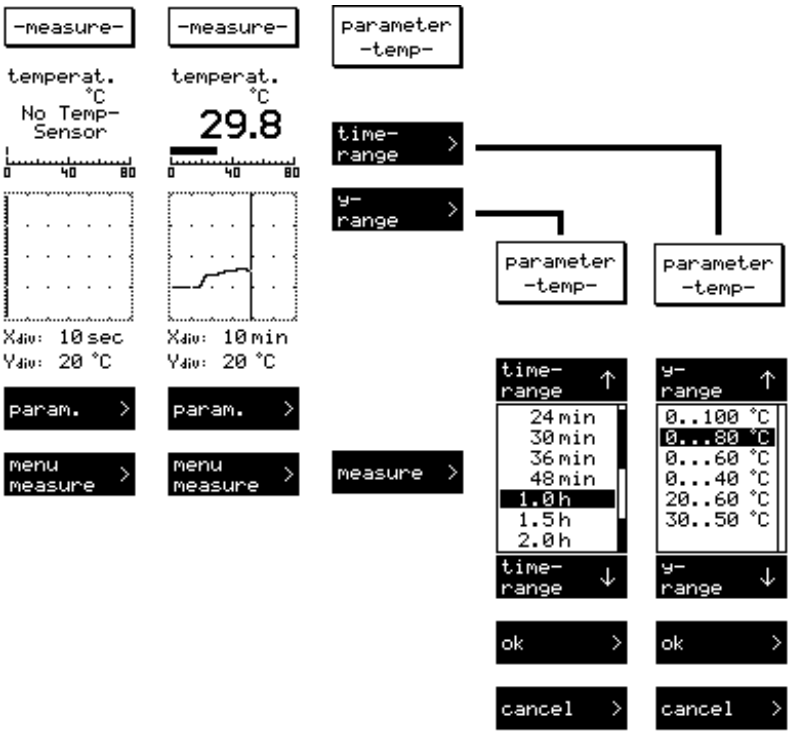


Examples for measurement displays



The handling of all menus corresponds to the already explained operating instructions. The individual menus and sub-menus are presented and explained below.

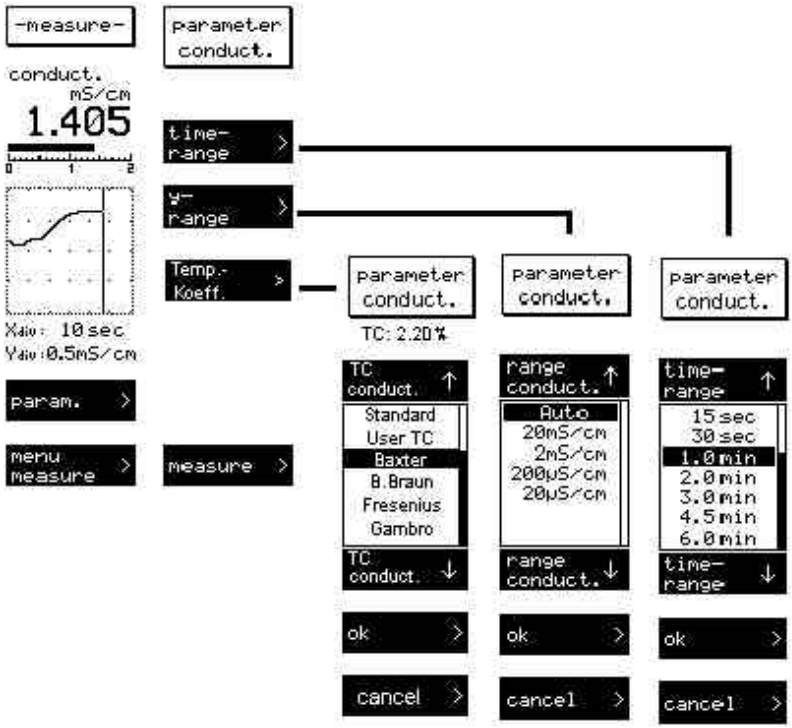
Temperature measurement



Time range

By activation of the function key *param.* you will receive a menu which allows to change the *time range*, in which the course graphic will run through horizontally once. Long term measurements up to twelve hours are possible. Since you do not have all possible times presented simultaneously, a black beam on the right side shows that above, or - like in the example - further options hide themselves below.
The selected *time range* is shown inverted. To change the *time range*, operate the function keys beside the arrows upward or downward. When you have selected the suitable *time range* for your application, return to the temperature measurement with the activation of *ok*. The length of the horizontal axis of the graph now corresponds to the chosen *time range*.

Conductivity measurement



After activation of the function key *param.* you will get to the menu which allows you to change the *time range* (horizontal axis of the graph) or the *y-range* (vertical axis) and also the temperature coefficient. By activation of the function key for the range to be changed you see the selection menus.
At the *time range* long term measurements up to twelve hours are possible. Since you do not have all possible times presented simultaneously, a black beam on the right side shows that above, or - like in the example -, further options hide themselves below.
The selected *time range* is shown inverted. To change the *time range*, operate the function keys beside the arrows upward or downward. When you have selected the suitable *time range* for your application, return to the temperature measurement with the

activation of *ok*. The length of the horizontal axis of the graph now corresponds to the chosen *time range*.
After the choice of the field *y-range* four fixed measuring ranges can be selected in the already explained way with the function keys beside the arrows. If you choose > *auto* <, the HDM99 automatically adjusts the measuring range so that an optimal graphic representation of the running measurement is assured.
With activation of the function key *ok* you arrive back in the conductivity measurement. The vertical axis of the course graphic as well as the scale length of the beam display now correspond to the measuring range you have chosen.
The temperature coefficient menu point allows many different setting possibilities. In the parameter menu for conductivity and also conductivity + temperature, it is possible to choose from a list of preset temperature coefficients of various dialysis machine manufacturers. These are listed by name.
There is also a standard value of 2.07% / °C and a user value. The user value can be changed in the usual way in the adjustment menu for conductivity. All settings are permanent until the next change. The selected setting is shown in the measurement menu.

Basic information about the temperature coefficient

The temperature coefficient in conductivity measurement is an important subject that is frequently neglected. The conductivity of a solution changes with the temperature. As the temperature rises, the conductivity of the measurement solution increases also. In order to arrive at meaningful measured values, the display value is compensated to 25°C. Expressed in another way, the display is always converted to a solution temperature of 25°C. The temperature coefficient with which the display is compensated is expressed in % / °C.
However, different solutions now unfortunately also have different temperature coefficients. For the display to be precise, the measuring unit must therefore be set to the temperature coefficient of the current solution. The average temperature coefficient for dialysate is 2.07% / °C. A value of 1.97% / °C is frequently used for natural water.
To perfect the chaos, the different manufacturers of dialysis machines also use different temperature coefficients in their machines.

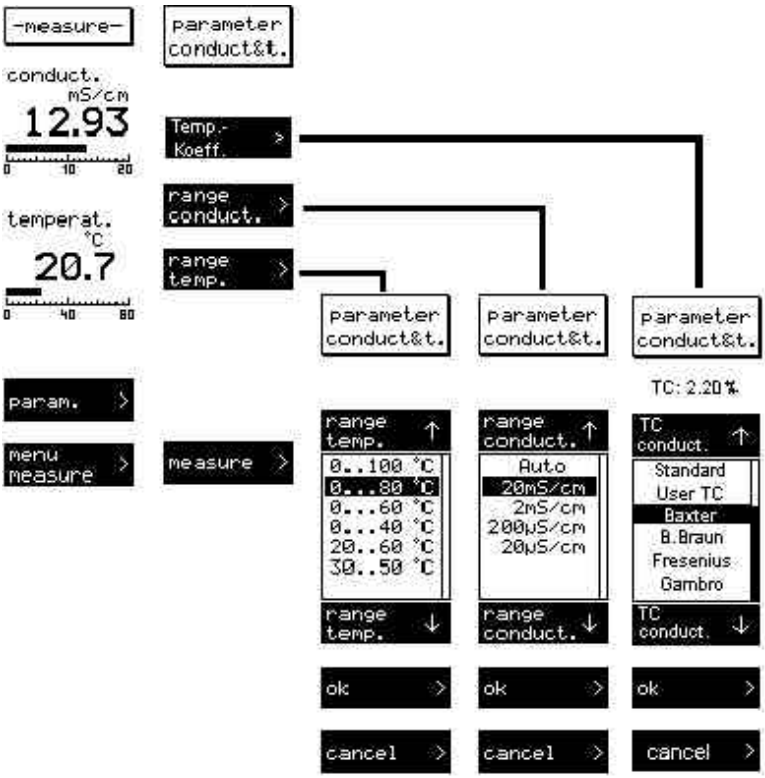
Baxter	2,20 %/°C
Braun	2,00 %/°C
FMC	2,10 %/°C
Gambro	1,80 %/°C
Hospal	2,07 %/°C
Nikkiso	
Bicarbonat	2,02 %/°C
Total conductivity	2,05 %/°C

This gives rise to the following recommendations:

1. You have machines from one manufacturer only:
   Use the temperature coefficient that the dialysis machine uses for compensation

2. You have machines from different manufacturers:
   Use as a temperature coefficient a mean value.
   2.07% / °C is recommended for this.

Conductivity and temperature measurement

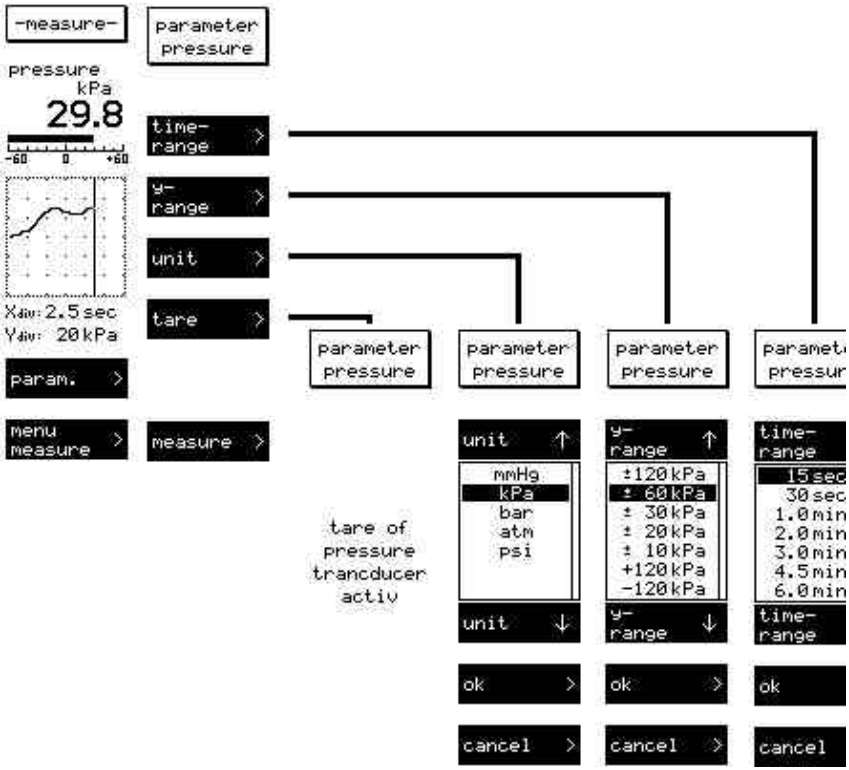


Measuring range conductivity

After the choice of the field *y-range* four fixed measuring ranges can be selected in the already explained way with the function keys beside the arrows. If you choose > *auto* <, the HDM99 automatically adjusts the measuring range, this way an optimal graphic representation of the running measurement is assured.
By activating the function key *ok* you will get back to the conductivity and temperature measurement. The vertical axis of the course graphic, as well as the scale length of the beam display, now correspond to the measuring range you have chosen.

The temperature coefficient menu point allows many different setting possibilities. In the parameter menu for conductivity and also conductivity + temperature, it is possible to choose from a list of preset temperature coefficients of various dialysis machine manufacturers. These are listed by name.There is also a standard value of 2.07% / °C and a user value. The user value can be changed in the usual way in the adjustment menu for conductivity. All settings are permanent until the next change. The selected setting is shown in the measurement menu.

Pressure measurement



Time range

After activation of the function key *time range* you will get to a menu which allows to change the *time range* (horizontal axis of the graph).
Long term measurements up to twelve hours are possible. Since you do not have all possible times presented simultaneously, a black beam on the right side shows that above, or - like in the example -, further options hide themselves below.
The selected *time range* is shown inverted. To change the *time range*, operate the function keys beside the arrows upward or downward. When you have selected the suitable *time range* for your application, return to the temperature measurement with the activation of *ok*. The length of the horizontal axis of the graph now corresponds to the chosen *time range*.

Unit

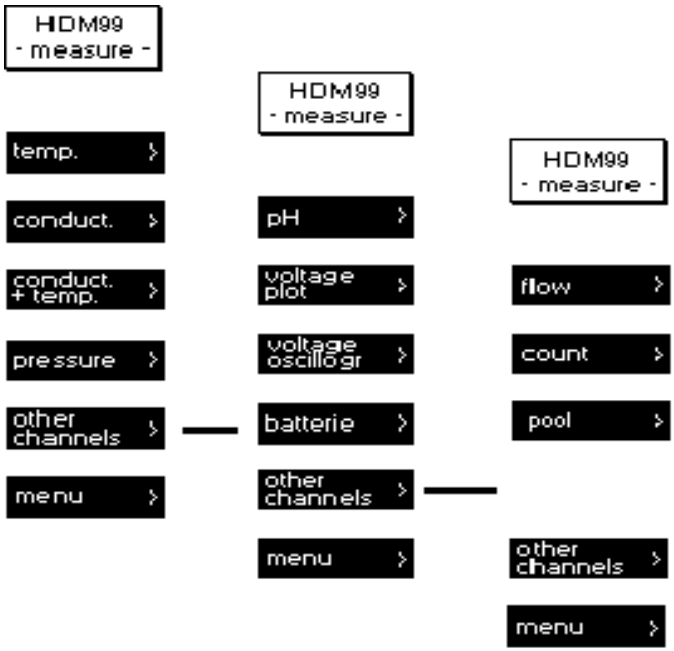
The *unit* for the pressure measurement can be chosen. The values are converted when the unit is changed. A new calibration is not necessary.
The selection of the unit is done in the familiar way with the function keys beside the arrows. With *ok* you return to the pressure measurement, where now the results will be shown in the newly chosen unit.

Taring

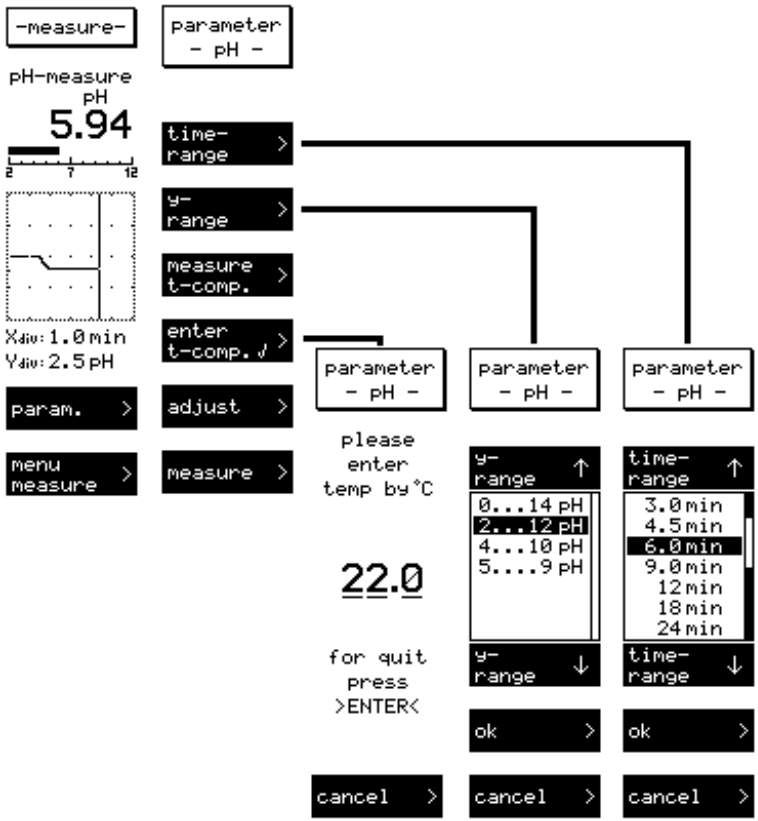
Caused by drift of the pressure probe, the pressure display may sway slightly around zero. With the function *tare* the display is set to zero. You must not apply pressure to the HDM99 during this function. This is assured when the pressure tube is not connected. Then the environmental pressure represents zero.
The choice of the function key *tare* results in the reset of the display to zero and the automatic return to the pressure measurement.

Further possible measurements

With the option *other channels* you can shift to a second measuring menu where you have the choice between two different modes of voltage measurement: the test for pH-value and the control of the charging state of the accumulators.
If you would like to return to the first measuring menu with conductivity, temperature and pressure measurement choose *other channels* again.



pH Measurement

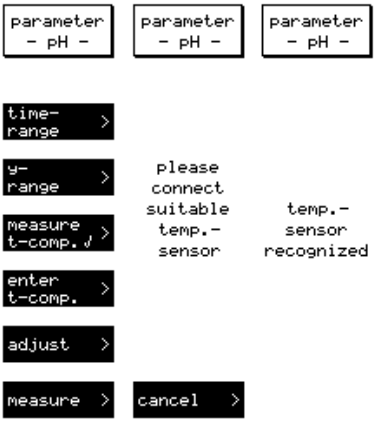


Time range

By activation of the function key *param.* you will receive a menu which allows to change the *time range* in which the course graphic will run through horizontally once. Long term measurements up to twelve hours are possible. Since you do not have all possible times presented simultaneously, a black beam on the right side shows that above, or -like in the example- further options hide themselves below.
The selected *time range* is shown inverted. To change the *time range*, operate the function keys beside the arrows upward or downward. When you have selected the suitable *time range* for your application, return to the temperature measurement with the activation of *ok*. The length of the horizontal axis of the graph now corresponds to the chosen *time range*.

Temperature compensation pH-measurement

For the temperature calibration of the pH-measurement the device offers two possibilities. The solution temperature can be measured via the conductivity and temperature electrode, or entered by hand. The chosen kind of the calibration is check-marked in the menu point *measure t-comp* or *enter t-comp*. If you choose *measure t-comp.* no further input is necessary. The temperature will be measured via the measuring cell.



By choice of *enter t-comp.* you will be asked to enter the solution temperature via the numeric keyboard. After confirmation with >*ENTER*< you will return to the menu for the parameter setting

Fundamental information about pH-measurement

For the measurement of the pH-value a combined electrode is used. pH electrodes are combinations of one reference electrode and one measuring electrode in a glass tube.
The pH-value in the dialysate is measured by an unbreakable pH-electrode. The glass body is protected with a plastic coat and due to the jelly-electrolyte-filling maintenance-free. This electrode` s diaphragm must be stored in 3 mol/l KCl-solution. The protection hood must be refilled every three to four weeks.

For pH-measurement in untreated desalinated water a particular electrode is necessary. This glass electrode is optionally available and has a 1 mol/l KCl reference electrolyte. The diaphragm of this electrode must be stored in 1 mol/l KCl-solution.

Before usage the electrode must be checked on exterior damage and glass crash. Crusts caused by leaking electrolyte can be removed easily by rinsing. The sample volume should be 100 ml dialysate or 1 l of untreated water. The sample volume is being led to the bottom of the vessel with a tube or hose for coming as little as possible into contact with air. The pH-value must be measured immediately in the same vessel. You have to make sure that the display stabilizes before the value is read. In stirred solutions the response rate is faster, the value, however, must be measured at resting fluid.

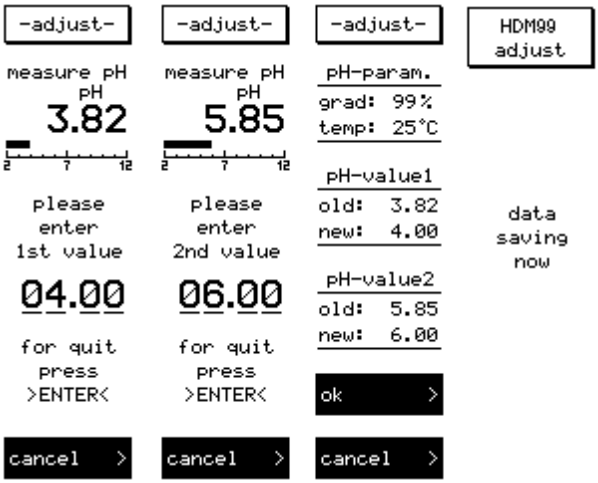
The pH-electrode must be dabbed only and never rubbed dry. The rubbing destroys the jelly layer on the glass surface which results in a longer response time of the electrode.

Due to the special electrode, for pH-measurement in untreated water further points need to be paid attention to: air bubbles in the membrane space of the electrode can be removed easily by shaking movements similar to a clinical thermometer. The reference electrolyte in this electrode can be refilled. Make sure that the refill cap is sealed with the rubber hood. The level of the reference electrolyte must always be sufficiently large.

Before the measurement the rubber hood must be removed, since otherwise no internal pressure compensation occurs. On the lower shaft of the electrode a plastic part is to be found which must always remain freely movable on the shaft. If the mobility of the plastic part should be restricted it can be released by rinsing with lukewarm water. This plastic part conceals an opening in the glass which must be covered always.

Pressure and currents have considerable influence on the pH-measurements. Therefore, it is necessary to accomplish the pH-measurement in a resting solution at environmental pressure.

pH-calibration in the measuring mode



Calibration

Before the adjustment the kind of temperature calibration must be set already.
Prepare two buffer solutions. The two buffers should not differ more than two activation decades. Choose, for example, pH4 and pH6. Carefully remove the protection hood for the measurement. Rinse and dab the pH electrode with distilled water before dipping it into the buffer. If necessary wash and dry the temperature sensor likewise, and put it into the measuring beaker. Wait until the display remains stable, then enter the pH-value via the numeric keyboard. Confirm your input with > *ENTER* <. Then wash and dry the electrode and dip it into the second buffer. When the value of the second buffer is entered, the display shows the actual calibration. If thereby the graduation (grad) is lower than 85%, the electrode could be worn out and must be replaced by a new one.
If you try to enter two equal values the reference *invalid data* appears after confirming with *ok*; at correct input the data will be saved, and you will return to the menu for the parameter setting.

Flow measuring

The current flow rate and the amount of flown liquid will be shown. The amount of flown liquid can be restored to zero by pushing *Reset.*

Management of different sensors

For the measuring of the flow different sensors will be used according to the measuring unit. The HDM99 governs up to 15 different sensors. For detecting the different sensors a code is put on them. This code is used for the internal choice of calibration data. The number of the connected sensors will be shown in the display.

Any sensor can be used which has an output signal that delivers a frequency proportional to the flow running. The amplitude at the entrance of the HDM99 may have a range of 5...24 V. For the current supply of the sensors 5 V DC/ 10 mA are available at the connection of the flow measuring.

Connection occupancy of the plug connection for the flow measurement

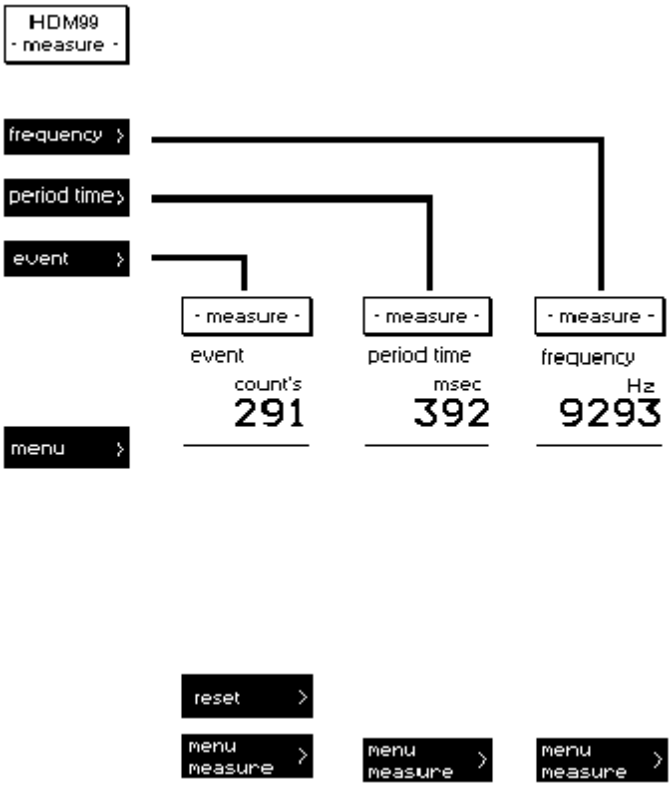
Pin	Meaning
1	currency supply sensor 5 V/ max 10 mA
2	signal input 5...24 V max 1 MHz
3	GND
4	code input 0
5	code input 1
6	code input 2
7	code input 3
8	shield for supply

Codes for the different sensors

Sensor	Pin 4	Pin 5	Pin 6	Pin 7	Remark
1	GND	GND	GND	GND	IBP Sensor 1
2	5 V	GND	GND	GND	IBP Sensor 2
3	GND	5 V	GND	GND	IBP Sensor 3
4	5 V	5 V	GND	GND	IBP Sensor 4
5	GND	GND	5 V	GND	IBP Sensor 5
6	5 V	GND	5 V	GND	IBP Sensor 6
7	GND	5 V	5 V	GND	IBP Sensor 7
8	5 V	5 V	5 V	GND	IBP Sensor 8
9	GND	GND	GND	5 V	
10	5 V	GND	GND	5 V	
11	GND	5 V	GND	5 V	
12	5 V	5 V	GND	5 V	
13	GND	GND	5 V	5 V	
14	5 V	GND	5 V	5 V	
15	GND	5 V	5 V	5 V	

If you use your own sensors, please choose a code beginning at number 9. The numbers 1...7 are reserved for the IBP sensors.

Counter

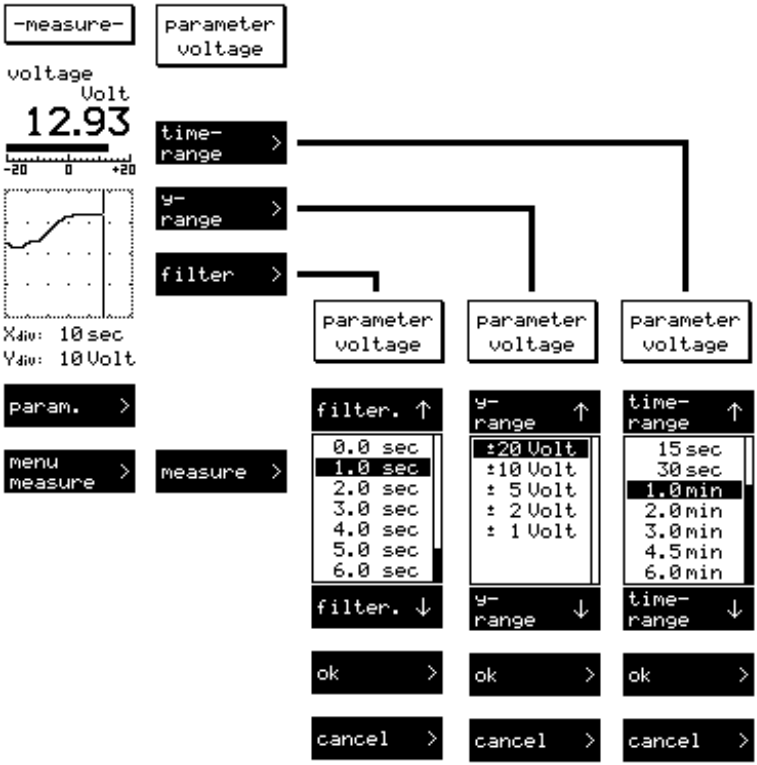


By operating one of the three functions you get optionally to the measuring menu for frequency, period duration , or event measuring.
All measurements can be done up to a frequency of 1 MHz. In the event measuring, the counted events can be reset to zero by operating *reset.*

Pool menu

Pool is a menu in which the following channels are displayed simultaneously:
Conductivity, temperature, pressure, flow.
All necessary settings, e.g. the temperature coefficient for the conductivity measurement or the unit for the pressure measurement, are taken from the corresponding measurement menus and can also only be changed there.

Voltage measurement - plotter



Time range

By activation of the function key *param.* you will receive a menu which allows to change the *time range* in which the graph will run through horizontally once. Long term measurements up to twelve hours are possible. Since you do not have all possible times presented simultaneously, a black beam on the right side shows that above, or - like in the example - further options hide themselves below.
The selected *time range* is shown inverted. To change the *time range*, operate the function keys beside the arrows upward or downward. When you have selected the suitable *time range* for your application, return to the

temperature measurement with the activation of *ok*. The length of the horizontal axis of the graph now corresponds to the chosen *time range*.

Damping

By operating the function key *damping* you will get a time table with a choice of periods between zero and ten seconds. Those can be chosen in the usual way with the function keys beside the arrows upward or downward. By use of the chosen period of time a gliding average value of the measured voltage will be calculated and put on display.
Please note that voltage sways which are shorter than the selected damping period can not be recorded.

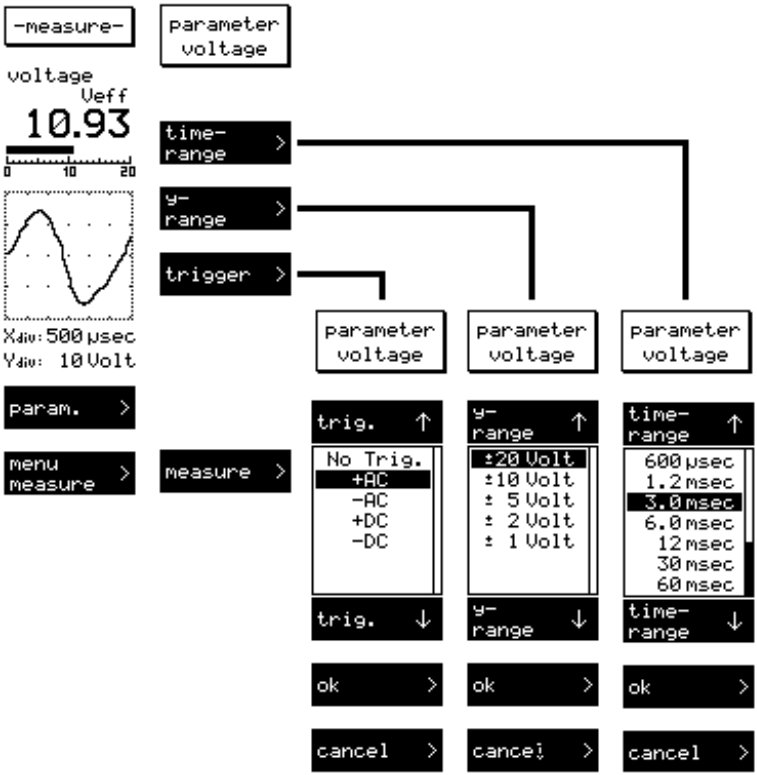
Voltage display

In the beam display the momentary value of the voltage is displayed. The voltage measurement in the plotter mode is particularly feasible for the measurement of voltages which are subject to no fast sway, therefore DC voltages and low frequency AC voltages.

Filter

By choice of the function key *filter* you will receive a time table with periods between zero and 10 seconds to select. Those can be operated in the familiar way with the function keys beside the arrows. An average value of the measured voltage over the selected period is calculated and reported. Please note that voltage sway which is shorter than the selected filter period can not be recorded.

Voltage measurement - oscilloscope



Time range

By activation of the function key *param.* you will receive a menu which allows you to change the *time range* in which the graph will run through horizontally once. Long term measurements up to twelve hours are possible. Since you do not have all possible times presented simultaneously, a black beam on the right side shows that above, or - like in the example - further options hide themselves below.
The selected *time range* is shown inverted. To change the *time range*, operate the function keys beside the arrows upward or downward. When you have selected the suitable *time range* for your application, return to the temperature measurement with the activation of *ok*. The length of the horizontal axis of the graph now corresponds to the chosen *time range*.

Voltage Display

In the beam display the R.M.S. value of the voltage is shown. The voltage measurement in the oscilloscope mode serves mainly for the measurement of voltages subject to higher frequency, therefore also AC voltages.

Measuring range

By activating the function key *y-range* it is possible to select a measuring range for the vertical axis of the graph via the arrow-keys which allows a maximum resolution of the voltage graph. The chosen measuring range is shown inverted. With the *ok*-key you transfer it to the voltage measurement.

Trigger

With this function key you will get to a menu where you can adjust the mode of the measurement triggering. Press the keys beside the arrows until the desired triggering is presented inverted. In detail the options mean:

No trig.	The applied voltage is shown without triggering.
+ AC	The rising edge of the average value of the applied voltage is triggered.
- AC	The falling edge of the average value of the applied voltage is triggered.
+DC	The rising edge at the zero passage of the voltage is triggered.
-DC	The falling edge at the zero passage of the voltage is triggered.

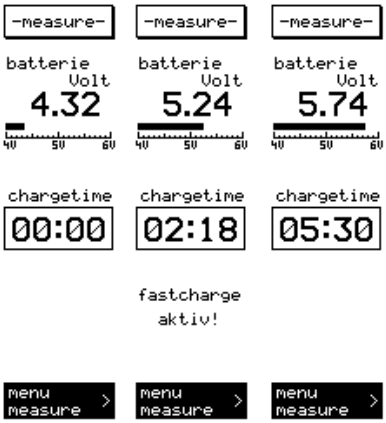
Take over the chosen triggering with the *ok*-key, and return to the voltage measurement. Please note that a successful triggering can only take place if a suitable voltage signal is applied. Otherwise >no trigger< appears in the graphic display.

Battery voltage

To avoid fail functions never use the HDM99 without batteries.

Charging state of the battery

If you select the function *battery* you will receive an information display about the battery voltage and the charging time.
The charging state of the installed accumulators can be estimated by the battery voltage. Above, you see from left to right the displays for empty, half and full.

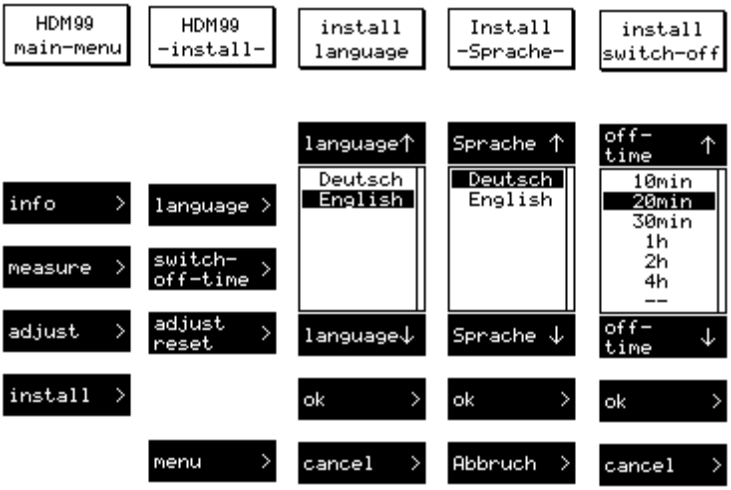


The computer processed charging starts with the connection of the charging device. There are two modes of charging, quick-charge and trickle. The light-emitting diodes beside the charging socket indicate these modes. Green stands for trickle, and the red LED indicates quick-charge. In all working modes the empty battery is indicated as *>Low-Bat<* in the uppermost menu field.

With activation of the key *measuring* you will return to the measuring menu.

For safety reasons never use the HDM99 with connected battery charger on a dialysis machine to which a patient is connected.

Installation



Language

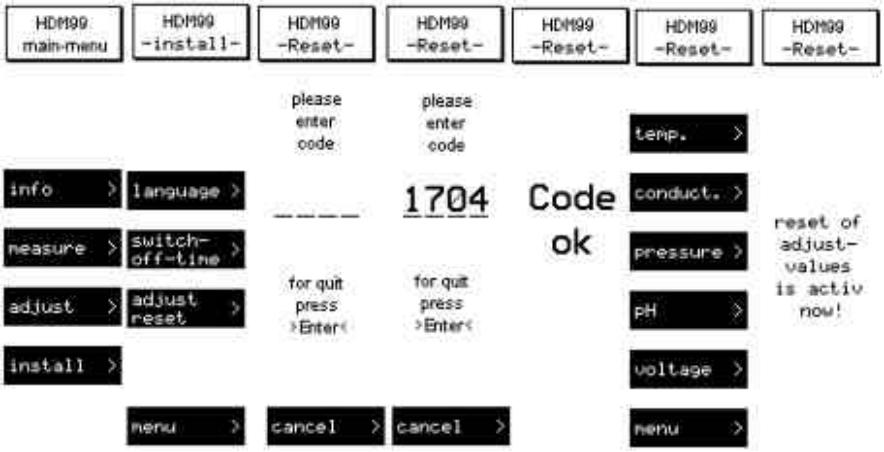
By pressing the function key beside the menu point *language* you will reach the language choice. With the keys beside the arrows you can select the desired language for your work with HDM99. The selection is shown inverted. With activation of *ok* you will return to the installation menu.
After altering the language the entire menu leadership and display appears in the chosen *language*.

Switch-off time

The *switch-off time* is the time after the last key activation. At the end of this time the device switches off automatically.
The activation of the function *switch-off* leads to a selection of times which can be selected with the arrow-keys. The chosen time is shown inverted and taken over with *ok* as new switch-off time in the installation menu. If >--< is chosen, the automatic power shutoff is cleared, the device remains active until it is switched off manually with the key >*OFF*<.

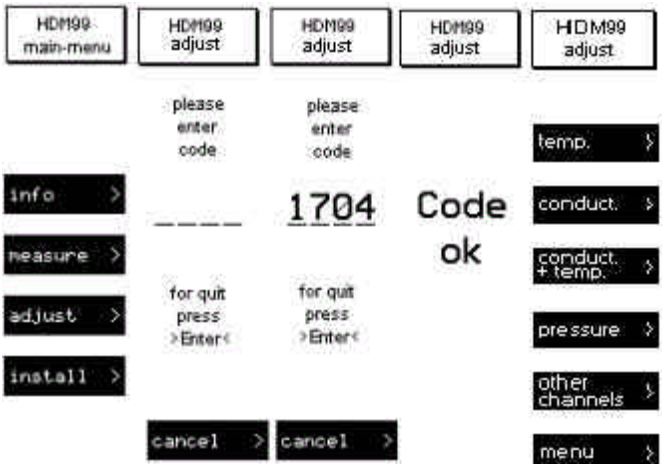
Adjust-reset

With the adjust-reset the calibration values for all measuring channels can be set to basic values. These basic values are the calibration values of the company conducted calibration. Operate the function key beside this menu point. You will have to enter a code via the numeric keyboard. This code is **1704**. When you confirm your input with >enter< you will receive the following images:



With the function keys beside the individual measuring channels you can decide on which calibration values this function should be applied. The calibration values will be reset to basic values.
After that, a new calibration of the reset measuring sizes is necessary.
The reset of the flow measurement only resets the parameters of the flow sensors 1....7. The possibly existing calibration values of own sensors remain unchanged.

Calibration of the HDM99



Adjustment

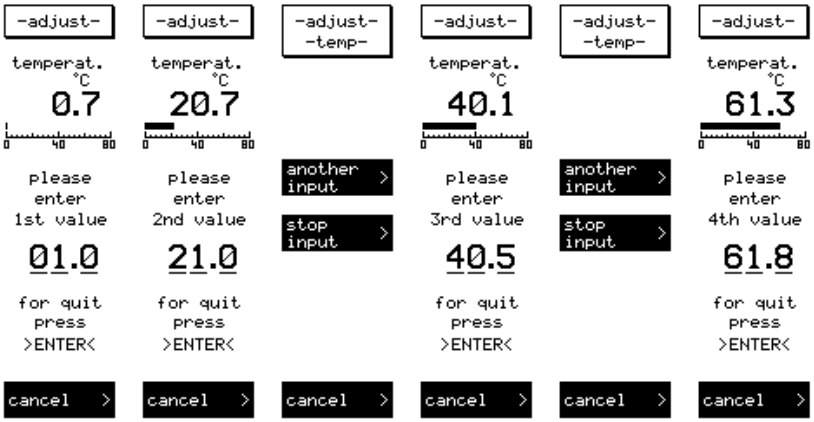
The entire calibration of the device is software controlled. Operate the function key *adjust* in the main menu to reach this function. You will be asked to enter a code via the numeric keyboard. This code is also **1704,** and must be confirmed with >*ENTER*<. After that, you are in the *adjust* menu.
The adjustment of the individual channels is slightly different. The pH- and voltage measurement is adjusted at two points. The temperature and pressure measurement is adjusted at minimally two points, alternatively up to six points. The advantage of more than two calibration points is the higher precision of the measurement as the non-linearity of the sensors will be equalized . The sequence of the calibration in reference to the level of the values is insignificant. Please note, that each value may be entered only once, since the system does not accept the data otherwise. The display will show *invalid data*.
The conductivity calibration results from measuring the cell parameter. Only one calibration point is necessary here.

The calibration of the flow measurement results from measuring of the impulses per liter. Up to 15 different sensors can be calibrated. Only one calibration point is necessary for this.

Should you be uncertain if you have entered all values correctly at any point in the run of the calibration of the device, choose the function *>cancel<*. Then no calibration will be accomplished, and you can start again.

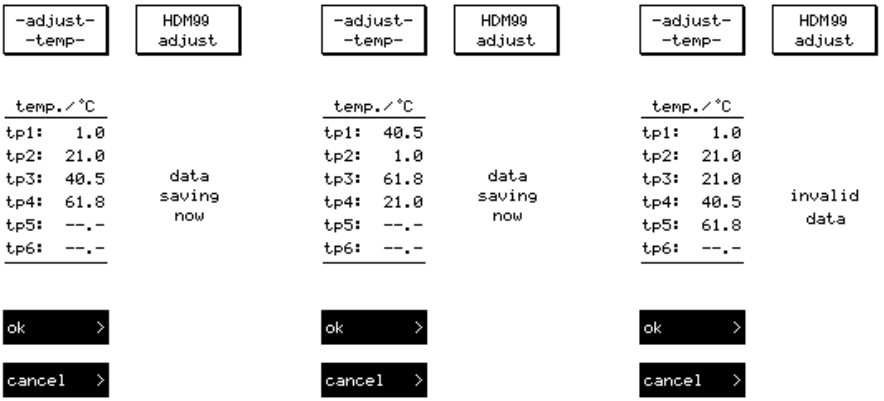
Should a calibration prove to be incorrect you can reset this calibration by the function c*alibration reset* within the installation menu.

Calibration of temperature measurement



We recommend an examination of the calibration once a year.

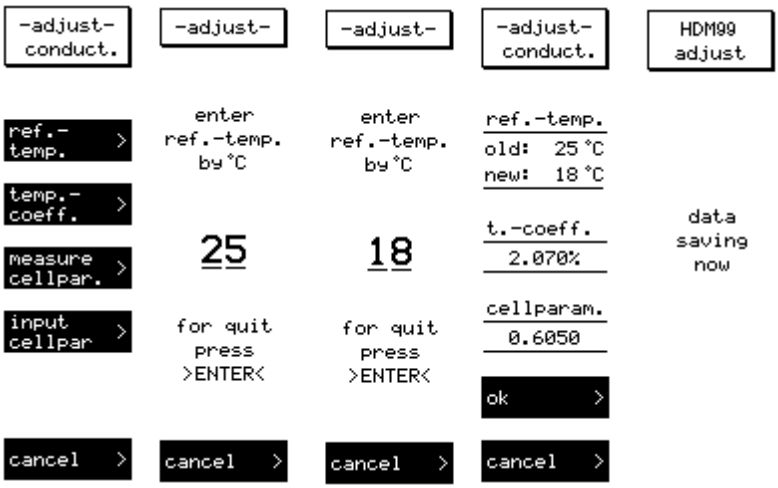
The calibration is to be accomplished as follows: Operate the function key *temp.* and follow the instructions on the display.
The temperature sensor is dipped into a fluid with known temperature, this temperature is then entered to the HDM99 via the numeric keyboard and confirmed with *>ENTER<*. The calibration points should be at the following points: 20 °C, 30 °C, 36 °C, 38 °C, 45 °C and 80 °C. After you have entered the last value press the function key *stop input*. If a higher precision is required at temperatures around 80 °C you can enter further calibration points at 60 °C and 85 °C. In this case choose *another input*.
The calibration value must be entered only if the displayed values are stable.


-adjust-
-temp-
HDM99
adjust
temp./°C
tp1: 1.0
tp2: 21.0
tp3: 40.5
tp4: 61.8
tp5: --.-
tp6: --.-
data
saving
now
ok >
cancel >
-adjust-
-temp-
HDM99
adjust
temp./°C
tp1: 40.5
tp2: 1.0
tp3: 61.8
tp4: 21.0
tp5: --.-
tp6: --.-
data
saving
now
ok >
cancel >
-adjust-
-temp-
HDM99
adjust
temp./°C
tp1: 1.0
tp2: 21.0
tp3: 21.0
tp4: 40.5
tp5: 61.8
tp6: --.-
invalid
data
ok >
cancel >

Calibration of conductivity measurement

We recommend an examination of the calibration once a month.

Reference temperature



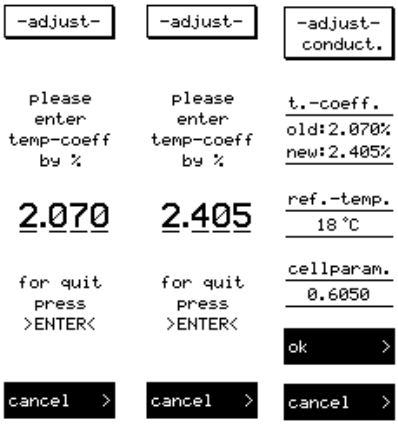
The usual reference temperature is 25 °C. For special applications other values can be used.

Use this function only if you are aware of the consequences. By using wrong values you will get a wrong conductivity value.

You reach this function by calling the menu point *ref.-temp.* There you can enter the new reference temperature via the numeric keyboard and confirm it with *>ENTER<*. By activation of the *ok*-key the new reference temperature will be saved in the software.

Temperature coefficient

For dialysate, the temperature-coefficient of the solution to be measured is 2.070%. For special applications this factor can be changed.



Use this function only if you are aware of the consequences. By using wrong values you will get wrong conductivity values.

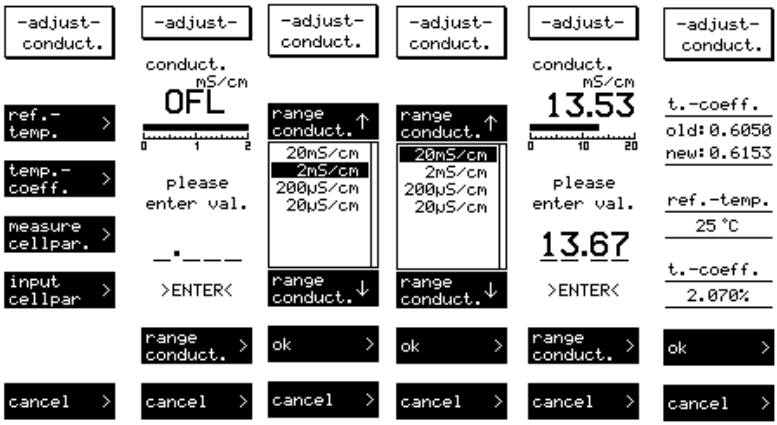
You reach this function by calling the menu point *temp.-coeff.* You can enter the new temperature coefficient via the numeric keyboard and confirm it with >*ENTER*<. Pressing the OK button transfers the new temperature coefficient to the program, but it is not used until it is selected in the parameters menu for Conductivity and Conductivity + Temperature.

By operating the menu point *conductivity range* you can choose the correct range with the arrow-keys. While calibrating the solution should have a temperature of approximately 25 °C. As soon as the measuring value in the display is stable the calibration value of the solution can be entered by the numeric keys and can be confirmed with >ENTER<.
After the calibration, all values relevant for the conductivity measuring will be indicated once more. By operating the ok-key all data will be saved.

While calibrating the conductivity use only fresh standard solutions. Never refill used solutions into the storage bottle! Keep the solutions in a cool place.

Measuring of the cell parameter

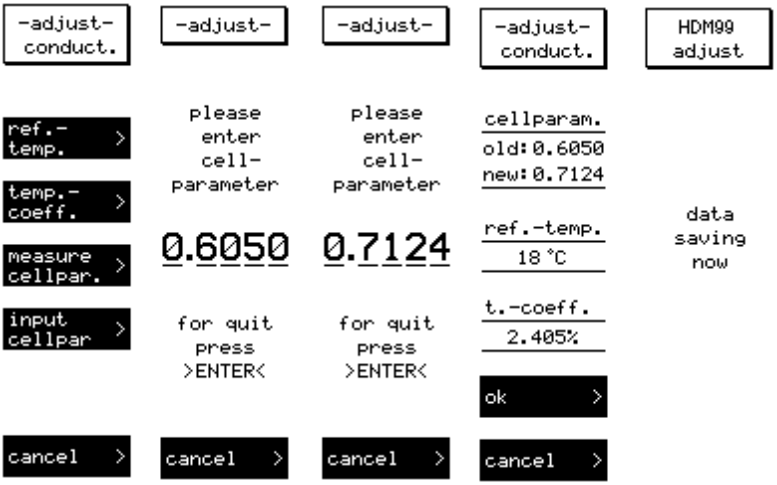
Before this function can be used, the reference temperature must be adjusted. It is sufficient for the conductivity calibration to know the cell parameter. If this is not known, or has been changed after longer use by deposits on the electrode, this function can be used to define the cell parameter newly. Call the function *measure cellpar*.in the adjust-menu.



In this function the measuring range will not be adjusted automatically. The adjustment for dialysate should be in the area of 13...14 mS/cm. Therefore the measuring range must be 0...20 mS/cm. If the measuring range is too small, the device indicates the overflow with *>OFL<* above the beam display. Via the menu point *measure conduct* you can choose the correct measuring range with the arrow-keys. During the calibration the standard solution should have a temperature of approx. 25 °C. When the measurement value in the display is stable, the conductivity value of the standard solution can be entered via the numeric keyboard and confirmed with *>ENTER<*. After the calibration, all values relevant for the conductivity measurement are indicated once more. With the *ok*-key the data will be saved.

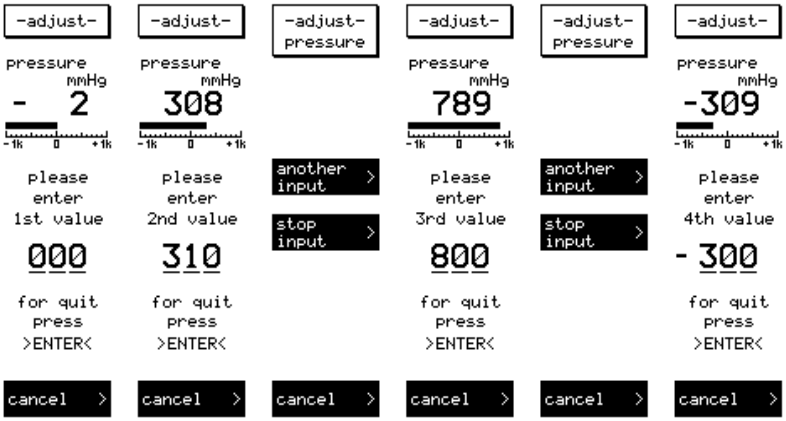
For calibration of the conductivity use only fresh standard solutions. Used solutions should not be refilled into the storage bottle! Keep the standard solutions in a cool place.

Enter cell parameter



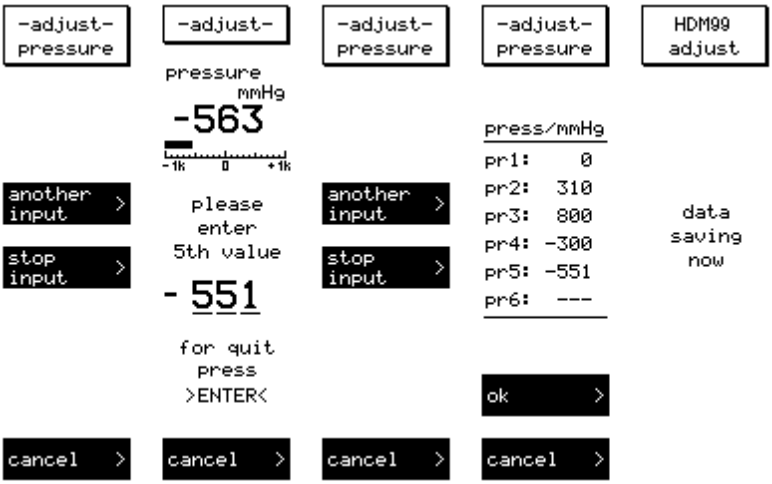
It is sufficient to enter the cell parameter of the electrode if it is known. This is profitable for an exchange of the electrode. Choose the function *input cellpar*. Enter the cell parameter via the numeric keyboard and confirm it with *>ENTER<*. Subsequently, all values relevant for the conductivity measurement will be indicated once more. With the *ok*-key the data will be saved.

Calibration of the pressure measurement



We recommend an examination of the calibration once a year.

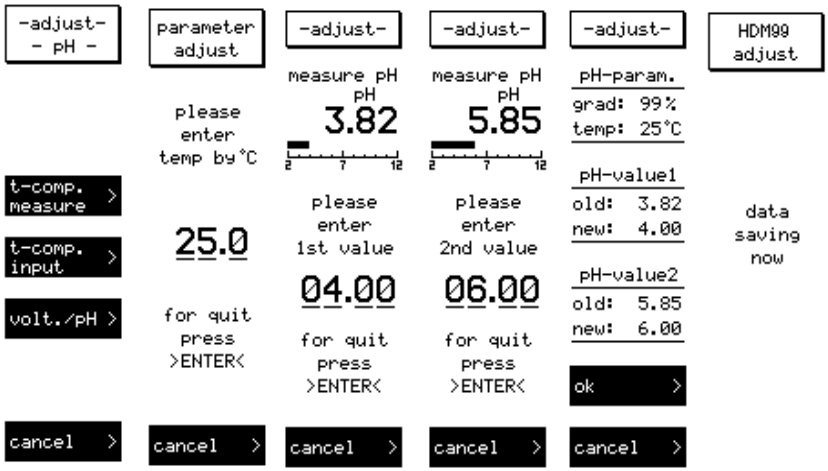
Operate the function key *pressure* in the adjust-menu. The calibration of the pressure measurement works like described for the temperature calibration at up to six points. After the input of two points you have the choice whether to terminate the calibration (function *stop input*), or to enter further values (function *another input*). The pressure probe is applied with known pressure, and then the values will be entered successively via the numeric keyboard and confirmed with *>ENTER<*. The calibration points for the measurement on dialysis machines should be at -400, -100, 0, +100 and +500 mmHg. If you call the function *stop input* after your input, the entered values will be indicated once more, and can be taken over with the *ok*-key.



The calibration values must be entered only if the values on the display are stable. The sequence of the calibration in reference to the level of the values is insignificant. Please note that each value may be entered only once since the system does not accept the data otherwise.

Calibration of pH-measurement

Please read the section **Fundamental information about pH-measurement.**



Temperature calibration of the pH-measurement

For the temperature calibration of the pH-measurement the device offers two possibilities. The solution temperature can be measured via the conductivity and temperature-electrode, or entered by hand. The chosen type of the calibration is check-marked in the menu point *measure t-comp* or *enter t-comp*. If you select *measure t-comp.* no further input is necessary. The temperature will be measured via the measuring cell, and you will get to the pH-measurement automatically.

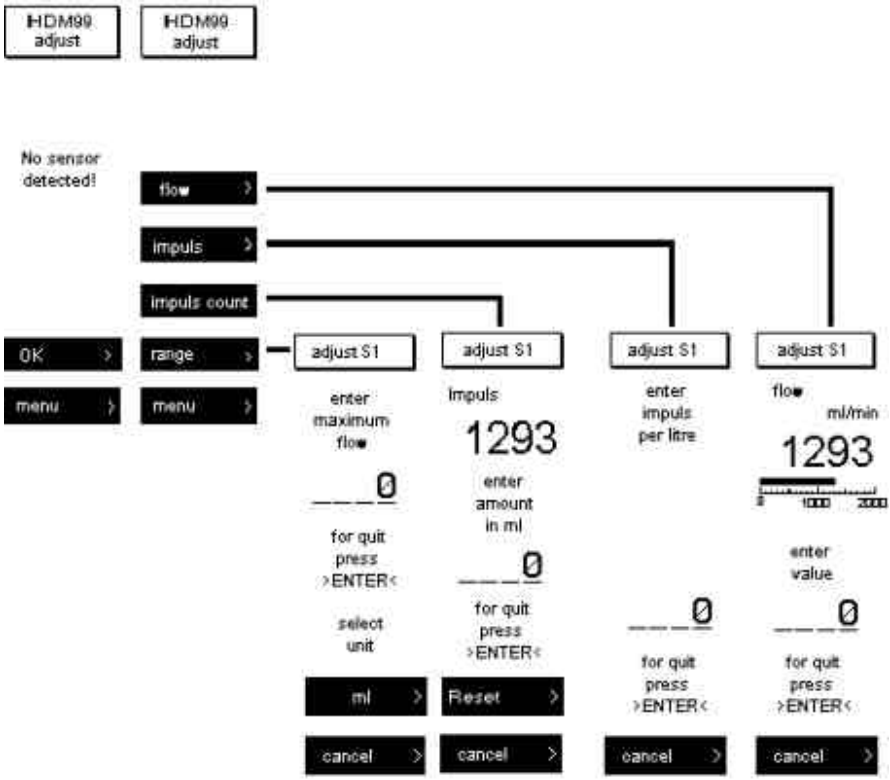
By choice of *enter t-comp.* you will be asked to enter the solution temperature via the numeric keyboard. After confirmation with *>ENTER<* you will return to the menu for the parameter setting

By choice of the function *calibration* you will reach the pH-calibration directly. The device uses 25°C as default.

pH-calibration

We recommend an examination of the calibration before each measurement.
Before calibration the type of temperature calibration must be selected already. Prepare two buffer solutions. The two buffers should not differ more than two activation decades. Choose, for example, pH4 and pH6. For the measurement remove the protection hood carefully. Rinse and dab the pH electrode with distilled water before dipping it into the buffer. If necessary wash and dry the temperature sensor likewise, and put it into the measuring beaker. Wait until the display shows a stable value, and then enter the pH-value via the numeric keyboard. Confirm your input with > *ENTER* <. Then wash and dry the electrode, and dip it into the second buffer. When the value of the second buffer is entered, the display shows the actual calibration. If thereby the graduation (grad) is lower than 85%, the electrode could be worn out and must be replaced by a new one.
If you try to enter two equal values, the reference *data invalid* appears after confirming with *ok.* At correct input the data will be saved, and you will return to the menu for the adjustment.

Calibration of flow



You will get to this function by operating the menu point *flow*. Up to 15 different sensors will be governed automatically. For calibration the correct sensor must be applied. In case that no sensor should be connected, a fault notice will occur. The running number of the recognized sensor will appear in the following presentations in the upper display. (Look also in the manual under flow measurement)

There are three different ways to calibrate a flow sensor.

- **Given amount of flow in ml/min or l/min**
- **Given number of impulses per liter**
- **Given amount of the quantity that has flown through**

Generally the sensor should be calibrated in the middle of the used measuring range.

Example: The sensor has a measuring range of 100... 2000 ml/min.
Operation range 100...600 ml/min. Then the calibration should be done around 350 ml/min.

Given amount of the quantity that has flown through

This way of calibration should only be used if no other possibility is available.
Ensure the constant flow through the sensor. Then enter the amount of the quantity that has flown through with the chosen unit, and confirm with *Enter*.
Check the calibration once again. This way the calibration is complete.

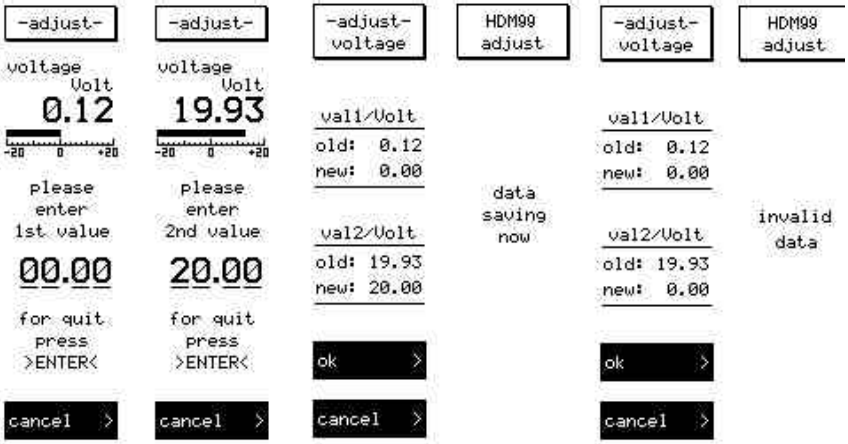
Given number of impulses per liter

This type of calibration should be used if the value is known.
Enter the value for the number of impulses/liter and confirm with *Enter*. This way the calibration is complete.

Given amount of the flown quantity

This type of calibration is the safest way to get to an exact result. Here the amount that has flown through the sensor within 5...10 min will be measured, and this value will then be entered. The HDM99 uses the value to calculate the impulses/liter. If you change to the menu point *enter impulse* after this calibration, you will get the new calibration value there.
Check the calibration once again. This way the calibration is complete.

Calibration of the voltage measurement



We recommend an examination of the calibration once a year.

You can reach this function by calling the menu point *voltage*. For the calibration of the voltage measurement you need two values. The calibration values should be at 0 and approx. 40 V=. The sequence of the calibration in reference to the size of the values is insignificant.
For the calibration value 0 V create a short circuit between the sockets. For other calibration values apply known voltages to the sockets.
The entering of the calibration values is carried out via the numeric keyboard. Please, pay attention that the values in the display are stable, then enter the calibration values, and confirm them with >*ENTER*<. After input of two calibration values the old and new values will be indicated once more, and can then be taken over with the *ok*-key.

Maintenance and care of the HDM99

Generally the HDM99 can be considered as an easy-care instrument. Like at all measuring instruments there is a minimum of maintenance and care necessary to ensure that all functions work flawlessly.

For safety reasons never use the HDM99 with connected battery charger on a dialysis machine to which a patient is connected.

Operate the instrument only in a dry environment, and do not touch it with damp hands. Ensure that no fluids intrude into the interior of the device, or into the sockets at the front. If this ever happens, open the device and remove the batteries. Sink the whole device into a vessel with distilled water over night. Afterwards, dry the HDM99, and send it to the producer for repair.
There are no parts in the HDM99 which you can repair yourself. Please, turn to our technical support at evident malfunctions that can not be removed by a new calibration of the device,. If the device should show any damages, or malfunctions by moisture influence, send it to the producer for repair.

Storage

Keep the device at a dry place. Suitable is, for example, the original packaging in which you have received the HDM99, or the carrying case offered by IBP as accessory. If you do not use the device over a longer period of time, you should connect it to the included charging device about every two weeks for one hour to avoid exhaustion of the installed batteries.

Cleaning

Never clean the device with any fluids! In case of pollution you can wipe the surface of the HDM99 with a dry and clean cloth.
For measurements in the lower conductivity range the cleaning of the conductivity / temperature measuring cell is recommended. Remove water-soluble substances by rinsing with de-ionized water, fats and oils with warm water and household dish washing detergent. Lime and hydroxid crusts can be solved by 10 per cent acetic acid. In each case, the measuring cell needs to be washed with de-ionized water after the cleaning.
Basically, the conductivity measuring cell does not decay. Particular measuring media (for example, strong acids and caustic solutions, organic solvents), or too high temperatures shorten the service life considerably, and/or lead to damages.

Calibration intervals

In the delivery state each device is newly adjusted. To assure a reliable function of the HDM99, the different measuring channels have to be calibrated at fixed intervals to examine their precision. This can be done by measuring known sizes, for instance, standard solutions, or proof voltages. If the measured values should deviate from the below indicated permissible limits, a new calibration of the instrument is necessary. We recommend the following intervals for the examination:

voltage measurement:	once a year,
pressure measurement:	once a year,
conductivity measurement:	once a month,
temperature measurement:	once a year,
pressure measurement:	once a year,
pH measurement:	before each measurement.

If for individual measuring channels the function *adjust reset* was used, then a new calibration is necessary for these channels.
To handle the calibration, please read the individual sections in which the calibration is described for the different channels.
Write down your calibration values and keep them until the next calibration. In case of damage, a calibration protocol can be important for the fault location.

If the calibration has been done by the IBP, a sticker will be put on showing the date of the next calibration necessary.

For liability reasons you should not carry out the calibration yourself. If IBP has been charged with the calibration, you will receive a calibration certificate which documents the calibration results.

Allowed limits

measuring channel	*measuring range*	*allowed limits*
voltage DC	40 V	± 0,05 V
voltage AC	40 V	± 0,05 V
pressure	-700...+1600 mmHg	± 2 mmHg
conductivity	0...20 mS/cm	± 0,1 mS/cm
temperature	30...40 °C	± 0,1 °C
	0...30 and 40...100 °C	± 0,2 °C
flow	100...600 ml/min	± 3 ml/min
pH	pH 0 ... pH 14	± 0,1 pH

Specifications for the HDM99

Conductivity

0...20 mS/cm in 4 ranges, quadro-pole-electrode, temperature compensation 20...40°C with 2,07 % per °C (adjustable), temperature sensor integrated in the measuring cell, reference temperature 25°C (adjustable), precision better than 0,25 % of full measuring range

Temperature

0...100°C, resolution 0,01 °C,
precision (30...40°C) better than ± 0,1°C, otherwise
better than ± 0,2 °C , probe integrated in combined conductivity / temperature electrode

Pressure measurement

-700...+1600 mmHg, precision better than 0,5 % of full measuring range, connection over tube nozzles

Flow measurement

Measuring range and precision are dependent on the sensor only. Typical precision better than 1% of the measuring range final value.

pH-measurement

Electrode is not included in the delivery extent, pH 0...14, resolution 0,01, precision better than 0,1 pH, temperature range 0...60 °C, temperature calibration manually or via probe in combined electrode.

Voltage

±40 V AC/DC, resolution 0,01 V, precision better than 0,15 % of measuring range value, frequency response in oscilloscope mode 3 kHz - 3 dB

Power supply

Ni-MH battery rechargeable with 12 V DC, operation time according to operation mode approx. 10 hours

Size

approx. 270 x 120 x 50 mm

RS-232-Interface

Pin occupation of the RS-232-interface

Pin No. HDM99	Signal		Pin No.	Signal computer
2	RD	>	3	TDX
3	TD	>	2	RXD
5	GND	>	5	(GND)SG
7	RTS	>	8	CTS
8	CTS	>	7	RTS

Interface parameters

The following interface parameters are fixedly adjusted at the HDM99

Baud rate	**9600**
Parity	**None**
Data bits	**8**
Stop bit	**1**

Data transfer

To receive measurements by the HDM99 via the serial interface, the following abbreviations must be sent via the interface. The entire communication takes place in readable ASCII-characters.

Command to HDM99	Reaction of the HDM99
HDMCD	**sends CD conductivity**
HDMTP	**sends TP temperature**
HDMPR	**sends PR pressure**
HDMPH	**sends pH pH value**
HDMVD	**sends VD voltage DC**
HDMVA	**sends VA voltage AC**
HDMVB	**sends VB voltage of the battery**
HDMAL	**sends successively CD TP PR pH VD VA VB**
HDMEE	**switches the transmission on**
HDMEA	**switches the transmission off**
HDMAE	**sends number of valid digits and units for CD TP PR pH VD VA VB**
HDMBSCE	**sends continuously measurements from current display of HDM99. The tact rate thereby corresponds to the tact rate of the graph in the display**
HDMBSCA	**cancels the command HDMBSCE and switches the transmission off**

HDMCMO Starts background measurement

HDMCMF Ends background measurement
MRES Reset unit counter for flow
hdm Fetches measured values via the RS232 interface

12964.12/ 24.7/ 750/ 7.00/ -0.03/ 0.05/6.12/1200/1000/79131/999999 + CR LF → 73 signs

Conductivity in µS/cm	**8 signs**
Temperature	**5 signs**
Pressure	**5 signs**
pH	**5 signs**
VDC in V	**6 signs**
VAC in V	**5 signs**
Vbattery in V	**4 signs**
Flow in ml/min	**5 signs**
Frequency in Hz	**6 signs**
Quantity in ml	**6 signs**
Event	**6 signs**
CR, LF	**2 signs**

A

Adjustment 43
Adjust-reset 42
ASCII 65

B

Battery 40

C

Calibration 30, 43, 45, 47, 51, 53, 55, 57, 60
Calibration intervals 60
cancel 44
care 58
cell parameter 49
charging device 11, 40, 58
Charging device 6
Cleaning 59
Combined electrode 6, 12

Conductivity 9, 10, 18, 21, 62
Connections 10

D

Data transfer 65
dialysate 28, 29, 48, 49
dialysis machines 9, 51
Druck 11
Druckmessung 31, 34, 62

F

Filter 37
Flow-through connector 6

G

Guarantee 8

H

hansen-connector 12
Hauptmenü 14

I

Info 14
Installation 41
Interface parameters 64

L

Language 41

M

Main menu 13
Maintenance 58
Measuring range 22, 39
Messen 15

O

oscilloscope 38

P

Permissible limits 61
pH 9, 10, 26, 28, 29, 30, 43, 53, 54, 60, 61, 62, 65
plotter 36
Pressure 6, 9, 10, 23, 29, 62

R

Reference temperature 47
RS232 Interface 64

S

safety 3, 11, 40, 58
software 2, 8, 14, 43, 47
Spannungsmessung 55
Specifications 62
Standard solution 6
Storage 58
Switch-off time 41

T

Taring 24
Temperature 9, 17, 28, 48, 62
Temperature coefficient 48
Temperature compensation 28
Time range 17, 23, 27, 36, 38
Trigger 39

U

Unit 24

V

Voltage 6, 9, 10, 36, 37, 38, 39

Y

y-range 18, 19, 22, 39